

# Studies of Leaching Characteristics of Arsenic and Antimony for Jinya Gold Mine

Wei Han<sup>1,3,a</sup>, Tang Zhongqin<sup>2,b\*</sup>, He Qian<sup>2,c</sup> and Chen Jianhua<sup>2,d</sup>

<sup>1</sup>Center of environmental emergency and accident investigation of Guangxi Zhuang, autonomous region, Nanning, 530028, Nanning, China

<sup>2</sup>Guangxi Colleges and Universities Key Laboratory of Minerals Engineering, 530004,Nanning, China

<sup>3</sup>Department of environmental science and engineering, Fudan University, 200433, Shanghai, China

<sup>a</sup>974233668@qq.com, <sup>b</sup>350839164@qq.com, <sup>c</sup>853556834@qq.com, <sup>d</sup>861382202@qq.com

## Abstract

Jinya gold mine is a typical Carlin type gold deposit in Fengshan, China and the main gold-bearing minerals are arsenopyrite and As-bearing pyrite. The mine drainage mainly contains arsenic and antimony, which can cause pollution to the environment. In the present study, the simulated rain water was used to leach the arsenic and antimony in solid waste obtained from the mine in order to investigate the leaching characteristics of arsenic and antimony. The results indicated that a large number of arsenic and antimony dissolved from the waste rock and tailings.

## Keywords

*Leach; Arsenic; Antimony*

## Introduction

The Carlin type of Jinya gold mine in Guangxi is a mesothermal-low hydrothermal temperature deposit with micro-fine disseminated ores [1, 2]. It is a typical arsenic-bearing gold deposit in China [3]. This ore contains many kinds of arsenic minerals, and its chemical composition, mineral composition and structure are very complex. It is difficult to utilize because of the low gold leaching rate. A large number of waster rocks and tailings dumped in the open air will release a lot of heavy metal ions in the process of mining and mineral processing. It has a devastating blow to the local ecological environment after precipitation or surface runoff into the water and soil. In the erosion of acid rain, there will be more heavy metal ions released from the waste rocks and tailings. Study has shown that the contents of arsenic and antimony were seriously over standard. Shang Zhengsong et al. used acid leaching method to simulate acid rain and released the heavy metals from the waste residue and the contaminated soil [4]. Yuan Wen et al. performed soil column experiments to simulate the washing away of heavy metals in mined landfill waste and in the mixed mined landfill waste with sludge [5]. The concentration of arsenic and antimony in water can be determined by soil column leaching test using simulated rains. In the present study, indoors leaching tests of waste rocks and tailings from Jinya gold in Fengshan, Guangxi were carried out using simulated rainwater to leach soil column containing arsenic and antimony metals. The results can provide the basis for controlling the water pollution and predicting the groundwater environmental impact.

## Soil Column Leaching Test

### Test Devices and Equipment

The laboratory tests are carried out on a simple deviceby leaching the soil column, peristaltic pump, and barrel-like composition. The inner diameter of the glass column is 10 cm and the height is 100 cm. The liquids are pumped with a peristaltic pump and are introduced from the top of the glass column. The top and bottom of the glass column are filled with a 2-3cm thick layer of quartz sand to prevent the clogging of soil column. The schematic diagram of leaching and scene diagram are shown in Figure 1 and Figure 2, respectively.

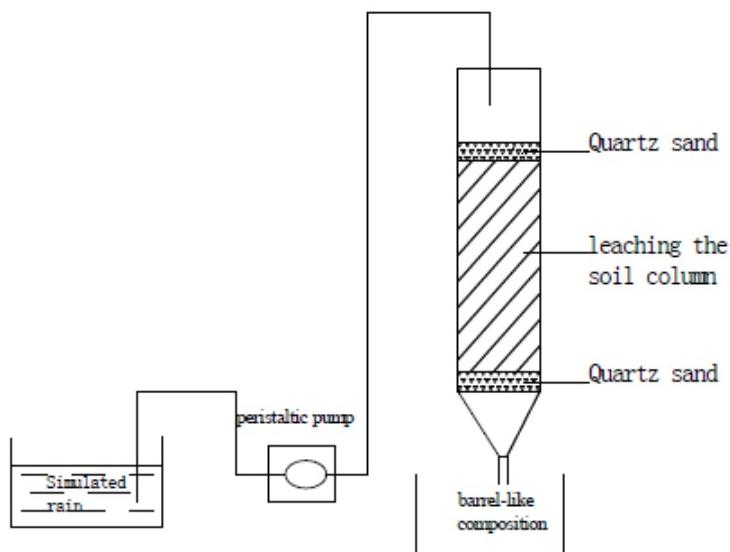


FIG. 1 SCHEMATIC DIAGRAM OF A SIMPLE INDOOR LEACHING



FIG. 2 SIMPLE DEVICE OF INDOOR LEACHING SITE MAP

### Test Methods

For heavy metal pollution, the pH value of rainwater directly affects the

leaching of harmful heavy metals in solid waste. The rainwater in Jinya mine was measured ,as shown in Table 1. It is indicated that pH value of the rainwater from is weak acid. According to the actual rainwater in Jinya mine, nitric acid is used to adjust the the pH value to prepare the simulated rainwater. From table 1 it can be seen that the simulated rainwater is very close to actual rainwater collected form Jinya mine.

Two kinds of solid waste, mining waste rock and tailings from concentrator, are used to fill the column, with filling height of 65 cm and diameter of 10 cm. The simulated rainwater is introduced from the top of the soil column with a certain velocity. The contents of As, Sb and other metals in the leaching solution are measured by atomic absorption spectroscopy after a certain time.

TABLE 1 CONCENTRATIONS OF METALS IN SIMULATED RAIN AND JINYA RAIN

	pH	Cu	Pb	Zn	Cd	Co	Ni	As	Sb
Simulated rain	6.08	<0.001	<0.001	0.011	<0.001	<0.001	<0.001	0.0011	<0.0005
Jinya rain	6.08	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	0.011	<0.0005

## Results and Discussion

The test point distribution for sampling is determined by checkerboard sampling sites method. The surface of the solid waste samples were collected at 0-50 cm and each sampling points collected solid waste samples were mixed, using quartering sampling method with a mixed sample of about 20kg. The size of the sample was below 0.1 mm powder. Solid waste mixed samples were used for laboratory soil column leaching test, and the tests were carried out on a simple device to simulate the leaching characteristics of arsenic and antimony in solid waste pollutants by simulated rain water.

The leaching test results of Neilang Ditch No. 1 waste rock, Neilang Ditch No. 2 waste rock and waste rock and Jinpan old tailings are shown in Table 2 and Table 3, respectively.

From Table 2, we can see that the concentration of arsenic and antimony leached from the 2nd waste rock of Neilang Ditch is relatively high. Followed is the 1st waste rock of Neilang, the lowest leaching concentration is of arsenic and antimony Nayuan. From the concentration of arsenic and antimony in Neilang Ditch No. 2 waste rock it can be seen that there still has a 4.42 mg/L of arsenic leached from the waste rock after 760 min. In addition, in Neilang Ditch No. 1 waste rock and Nayuan rock element with the increase of time decreased slightly, from 0.037 mg/L to 0.023 mg/L and 0.057 mg/L to 0.044 mg/L, respectively. According to Table 3, the contents of arsenic and antimony in the tailings are high especially in the Jinpan Gold Mine No. 3 tailings with the leaching concentration about 1.46 mg/L of arsenic and concentration about 0.075 mg/L of antimony after two months. The concentrations of arsenic and antimony in dissolution liquid from the two old tailings almost did not change with the increase of time.

TABLE 2 THE CONCENTRATIONS OF ARSENIC AND ANTIMONY OF WASTE ROCK LEACHED BY SIMULATED RAINWATER

samples	Time (min)	As (mg/L)	Sb (mg/L)
Neilang Ditch No. 2 waste rock	30	4.65	0.29
	60	5.07	0.28
	760	4.42	0.17
Neilang Ditch No. 1 waste rock	30	0.51	0.056
	60	0.51	0.056
	580	0.45	0.041
Waste rock of Nayuan	30	0.037	0.0062
	60	0.036	0.0065
	578	0.023	0.0046

TABLE 3 THE CONCENTRATIONS OF ARSENIC AND ANTIMONY OF TAILINGS LEACHED BY SIMULATED RAINWATER

samples	Time (day)	As (mg/L)	Sb (mg/L)
Jinpan Gold Mine No. 1 tailings	30	0.15	0.011
	60	0.18	0.013
Jinpan Gold Mine No. 3 tailings	60	1.46	0.075
	120	1.46	0.078

## Conclusions

From the test results it can be known, arsenic and antimony were dissolved from waste rock and tailings under the action of simulated rainwater especially in Neilang Ditch No. 2 and Jinpan Gold Mine No. 3 tailings. In addition, the concentrations of arsenic and antimony in dissolution liquid from the two old tailings almost did not change significantly with the increase of time. The pollutant source intensity was determined, which can provide the basis for water pollution controlling and groundwater environmental impact prediction.

## REFERENCES

- [1] Wang Guotian. Formation mechanism of micro grained disseminated JY gold deposit in Northwest Guangxi [J]. *Guangxi geology*, 1989, 2(2):15-24.

- [2] Wang Hongmei, Zhang Wenhui, Xie Shu, etc. Organic geochemical characteristics of gold deposit in Guangxi [J]. Journal of rock, 2000, 16(4):602-608.
- [3] Yang Hongying, Yang Li, Tong Linlin, Fan Youjing. Study on the technological mineralogy of gold extraction gold in Guangxi [J], Journal of Northeastern University (NATURAL SCIENCE EDITION), 2007.8:1156-1158.
- [4] Shang Zhengsong, Liu Fang, Liu Rong, Yang Aijiang, Shen Wantun. The release characteristics of heavy metals in the waste residue of Xiangxi vanadium mine and the soil of the soil in acid leaching [J]. Environmental protection technology, 2011, 2:10-14.
- [5] Yan Wen, Fang Hailan, Zhao Youcai. Experiment Study of Heavy Metal Washing Away in Aged Waste [J]. Environmental Sanitation Engineering, 2007.4:34-38.